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The Use of Sodium Tetraphenylboron as a Means of Identifying and Isolating Alkaloids*

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The use of a new reagent, sodium tetraphenylboron, as a means of identifying alkaloids is described. Methods are given for isolating alkaloid complexes and for determining their physical constants as an aid in the identification of the alkaloids. A simple method of recovery of the alkaloids is also given.

THIS LABORATORY has been conducting a search for new alkaloids from plants for use as medicinals, antifungal agents, or insecticides, with a view to the possible development of new cultivated crops as a source of income for the farmer. The screening followed the usual pattern of extracting dry plant material with a suitable solvent, such as 85 per cent methanol or ethanol, concentrating the solution under vacuum, dissolving the residue in slightly acidic water, and testing for the presence of alkaloids. Solutions of silicotungstic acid and Mayer's reagent were used for the test.

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Schultz and Mayer (1) have described the use of a new reagent for the qualitative and quantitative determination of nitrogen-containing medicinals, which included alkaloids. The reagent was known as "Kalignost," sodium tetraphenylboron. They used an aqueous solution of this reagent to precipitate alkaloids from a slightly acidic solution which had been heated to 70°. Fischer and Karawia (2) listed the melting points of 17 alkaloid complexes of sodium tetraphenylboron which they had prepared. More recently, Barnard (3) published a comprehensive bibliography on the uses of sodium tetraphenylboron as a complexing agent.

We prepared solutions of thirty-four known alkaloids of various structures, in order to make a comparison of the sensitivity of Mayer's

reagent and sodium tetraphenylboron toward alkaloids, by observing the amount of precipitate obtained with these reagents. We also investigated the possibility of using the precipitate obtained with sodium tetraphenylboron as a means of isolating the free alkaloid by gently heating the complex with dilute alkali. It was possible, in most cases, for us to regenerate the alkaloid by this method.

We prepared sodium tetraphenylboron derivatives of twenty-one known alkaloids to aid us in the identification of alkaloids from the new plant sources. The derivatives were purified by crystallization from suitable solvents, melting points were recorded, and Kjeldahl nitrogen analyses were made to check on the purity of the compounds. The free alkaloids were recovered by heating the complexes in the presence of alkali, except in a few cases where it was impossible to recover the alkaloid due to unfavorable conditions.

EXPERIMENTAL

Materials.—The reagents used were sodium tetraphenylboron (purchased from J. T. Baker Chemical Co.¹) and Mayer's reagent. The alkaloids were of commercial grade, with the exception of the tomatidine derivatives, nicotine, solanthrene, solanine, and solanidine, which were prepared in this laboratory.

Comparison of Sodium Tetraphenylboron with Mayer's Reagent in the Detection of Alkaloids.—Duplicate samples of approximately 20 mg. of alkaloid were dissolved in 15 cc. of water. To one set of samples, 6 drops of glacial acetic acid was added and the solutions were heated to 70° on the steam bath. A 0.1 *M* solution of sodium tetraphenylboron in water was added to the heated samples until no further precipitation occurred. To the other set of samples, 5 drops of a 15% hydrochloric acid solution was added. Then a slight excess of Mayer's reagent was added. Visual comparisons of the amount of precipitate or turbidity were made for each set of samples. A designation of 3 was given for a heavy precipitate, 2 for a medium precipitate, 1 for a turbid solution and 0 for no precipitate. The results are listed in Table I.

Preparation of Complex for Analysis.—Approximately 0.5-Gm. samples of alkaloid were dissolved in a small quantity of water which had been made slightly acid with acetic acid. The solutions were heated to 70° on the steam bath. An equimolar solution of sodium tetraphenylboron plus a 0.1-Gm. excess in water was added to the warm alkaloid solution and the precipitate was allowed to settle. The precipitate was recovered by filtration and dried in a vacuum oven. The precipitate was weighed, then recrystallized from either acetone or ethanol. Melting points were determined on a Kofler Micro Hot Stage with a calibrated thermometer. Kjeldahl nitrogen determinations were made on all compounds.

¹ Mention of firms or trade names does not imply endorsement of the U. S. Department of Agriculture over similar firms or products not mentioned.

The alkaloid was regenerated by the addition of a 5% solution of sodium hydroxide to the solution of the complex dissolved in either acetone or ethanol. The solutions were heated gently on the steam bath.

TABLE I.—A COMPARISON OF THE SENSITIVITY OF SODIUM TETRAPHENYLBORON AND MAYER'S REAGENT TOWARD ALKALOIDS

Alkaloid	Sodium Tetraphenylboron ^a	Mayer's Reagent ^a
Aconitine	2	2
Agaricin	1	1
Aspidospermine	2	2
Atropine	3	3
Berberine HCl	3	3
Betaine	2	0
Brucine	3	1
Cinchonidine sulfate	2	2
Cinchonine sulfate	2	3
Cocaine	3	3
Codeine	3	3
Colchicine	1	2
Dihydrotomatidine	1	1
Emetine HCl	3	2
Ephedrine sulfate	1	0
Homatropine HCl	3	1
Hydrastine HCl	3	3
Hyoscyamine	1	1
Jervine	3	3
Lobeline sulfate	3	3
N-Acetyltoomatidine	1	0
Physostigmine	2	2
Pilocarpine HCl	3	2
Quinidine sulfate	3	3
Quinine sulfate	3	3
Sanguinarine nitrate	2	1
Scopolamine HBr	2	1
Solanidine	2	2
Solanine	1	0
Solanthrene	1	1
Sparteine sulfate	2	3
Tomatidine	2	0
Tomatine	1	0
Yohimbine HCl	3	3

^a 3 = heavy precipitate; 2 = medium precipitate; 1 = turbid solution; 0 = no precipitate.

for 15 minutes. The solvent was removed by means of an air stream and the residue was extracted with chloroform. The chloroform after being washed with water to remove alkali, was dried and then concentrated. The recovered alkaloids were weighed and identified by means of melting points. The results are shown in Table II.

DISCUSSION

In comparing the sensitivity of Mayer's reagent and sodium tetraphenylboron toward the alkaloids listed in Table I, it will be noted that at the concentrations which we were using, Mayer's reagent failed to show any turbidity with ephedrine, solanine, tomatidine, tomatine, N-acetyltoomatidine, or betaine. In the other solutions tested, the use of sodium tetraphenylboron was as good as or superior to Mayer's reagent. Since sodium tetraphenylboron will also precipitate potassium and ammonium ions out of solution, it is necessary that the use of re-

TABLE II.—CHARACTERISTICS OF ALKALOID-SODIUM TETRAPHENYLBORON COMPLEXES

Alkaloid	Yield of Complex, %	M. p. of Complex, °C.	Nitrogen, %		Regenerated Alkaloid Recovery, %
			Actual	Theoretical	
Aspidospermine	84.5	126-8	4.32	4.15	72.6
Atropine	97.4	141-4	2.36	2.30	60.8
Berberine HCl	68.4	204-7	2.12	2.13
Brucine	94.4	156-8	3.82	3.91	90.8
Cinchonidine sulfate	60.0	133-5	4.40	6.37	97.5
Cinchonine sulfate	55.6	211-4	5.82	6.17	100
Colchicine	49.2	100-5	2.30	1.78	8.3
Emetine HCl	80.6	111-4	2.73	3.50	85.6
Ephedrine sulfate	97.0	135-8	2.83	2.89	100
Homatropine HCl	97.4	151-4	2.34	2.36	3.8
Hydrastine HCl	92.6	109-11	2.00	1.99	76.2
Hyoscyamine	98.2	142-5	2.33	2.30	15.0
Jervine	78.4	125-6	1.88	1.91	100
Nicotine	100	131-3	6.04	5.82	98.4
Protopine	100	130-5	1.95	2.08	100
Quinine sulfate	87.8	163-5	4.23	4.34	100
Sanguinarine nitrate	73.8	140-3	2.19	2.09	78.5
Scopolamine HBr	95.0	145-8	2.26	2.24	15.2
Sparteine sulfate	100	205-8	4.90	5.06	100
Tomatidine	84.8	129-31	1.88	1.90	99.1
Yohimbine HCl	91.2	159-61	3.98	4.17	2.4

agents or solutions containing these ions be avoided.

The yields of the alkaloid complexes were fairly high, as shown in Table II. The melting points in some cases overlap, precluding their use in the identification of the alkaloid without additional information. The amount of alkaloid which we recovered was, in some cases, very low. This may be due to

overheating or to the use of too strong an alkali solution.

REFERENCES

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